КОНСОРЦИУМ ЭКОНОМИЧЕСКИХ ИССЛЕДОВАНИЙ И ОБРАЗОВАНИЯ - РОССИЯ И СНГ
ECONOMICS EDUCATION AND RESEARCH CONSORTIUM – RUSSIA AND CIS

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BANKING SYSTEM OPERATIONS DURING TRANSITION TO MONETARY STABILITY

Final Report

Moscow

2001

CONTENTS

1. Abstract

The model presented in the paper fills the gap between theoretical discussions and empirical evidence on the macroeconomic reasons of the banking crises.

It is argued that opposite dynamics of some indicators for different crisis syndromes are responsible for the fact that most econometric studies report insignificance of some indicators known from case studies to be important. In fact influence of these factors is not "captured by other indicators" as it is often suggested but "cancelled out" when all crises types are treated as essentially the same.

Sample of countries was selected by pooling countries with more then 2 consecutive years with inflation rate above 40% p.a. The sample includes 46 countries. Of these countries only 2 - Suriname and Sudan did not have banking crisis (most likely due to data omissions).

Economic discussion suggests that different crisis types are characterized by different set of pre-crisis macroeconomic indicators development. We suggested that along with traditional measures of banking crisis risk factors some factors work in combination with other factors. Namely we suggested that real exchange rate change appreciation is dangerous if accompanied with fast credit growth. And in situation of modest credit growth more danger comes from real exchange rate depreciation. It is argued that it is this opposite influence is responsible for failure of other studies to find support for well known from case studies importance of real exchange rate dynamics in run-up to the crisis.

The other two-sided factor is credit growth. In conditions of high inflation it supports income base of banks and diminishes probability of the crisis. At the same time credit growth during low inflation in some conditions (namely real exchange rate appreciation - see above) may well end with a banking crisis.

Based on this theoretical discussion we split some variables to capture their opposite influence on provability of banking crisis in different syndromes and constructed variables specific for every crisis type.

Logit regression model showed significant expected different signs before variables constructed to model different crisis scenarios. Results support importance of different indicators in different crisis syndromes.

2. Introduction

Studies of the banking crises proliferated in the recent decade with high incidence of banking crises in developed and developing countries. The literature on banking crises is clearly split into two camps. One camp based on macroeconomic cross-country data explores uniform reasons of the crises, the other based on bank-specific and country-specific data presents case studies of banking crises.

One of the striking results is failure of cross-country studies to show significance of some of indicators reported to be very important is case studies. The most notorious example is insignificance of devaluation in cross-country regressions.

This study attempts to overcome this problem by introducing a new model. In this model it is presumed that banking systems are susceptible not to isolated external shocks but rather to complex crises syndromes.

Each syndrome is characterized with common dynamics of macroeconomic indicators in the run-up to the crisis. But some syndromes may involve opposite dynamics of some indicators which in both cases may be significant.

Understanding of different nature of banking crises during and after disinflation is very important for timely preparation for corrective action in implementation and design of disinflation programs. One of important inferences from the presented model is that transition from high inflation tends to be accompanied not be one as it is generally

accepted but by three different types of banking crises that may occur one by one or some crises may be skipped.

This paper is structured as follows. Section 3 presents review of literature and conceptual framework of the study. 4th section presents then data and variable selection. 5th section presents econometric model, and finally estimation results are presented in section 6. And section 7 concludes the paper.

3. Review of literature / Conceptual framework

Empirical studies of the causes of the banking sector problems are divided into two camps. The first (the older one) typically uses data for individual banking crisis and analyses isolated cases of banking problems. Some studies in this group try to generalize inferences from case studies (Lindgren, Garcia and Saal (1996) and Caprio and Klingebiel (1996)).

The second camp explores macroeconomic factors of banking crises and uses cross-country sample data. Due to availability of data on banking crises experience of different countries after Lindgren, Garcia and Saal (1996) and Caprio and Klingebiel (1996) studies, the second approach gained more popularity in recent years.

The shocks associated with episodes of banking sector problems highlighted by the literature include cyclical output downturns, terms of trade deteriorations, devaluations, declines in asset prices such as equity and real estate (Caprio and Klingebiel, 1996, Lindgren *et al.,* 1996, Kaminsky and Reinhart, 1996).

Banking sector problems may also follow successful stabilization in countries with a history of high inflation. As shown by English (1996), chronic high inflation tends to be associated with an overblown financial sector, as financial intermediaries profit from the float on payments. When inflation is drastically reduced, one of banks' main sources of revenue disappear, and generalized banking problems may follow.

Banking sector difficulties in Brazil and Russia have been explained in this way (Lindgren et al. (1996), Dmitriev et. al. (1996)).

Credit booms as factors for future crisis are emphasized in Gavin and Hausmann (1996), Kaminsky and Reinhart (1996), Honohan (1997).

To summarize, most commonly reported macroeconomic causes of banking crises fall in 3 groups:

(1) sharp fall of inflation rate,

(2) unsustainable credit booms,

(3) balance-of-payments problems and sharp changes of assets prices.

Case studies results are only partially supported by econometric cross-country studies. Caprio and Klingebiel (1996) question relationship between banking crises and previous credit booms. No study reported support for importance of devaluation. This relationship is so obvious both from case studies and theory that researchers typically in search for excuses explain such results in the way that influence of devaluation is captured by other factors (see e.g. Demirguc-Kunt and Detragiache (1997)).

Cross country studies usually try to directly estimate the probability of a banking crisis (using limited-dependent variable models) and identify the variables that statistically aid in predicting crises. Empirical methodology of these studies differs a lot, although there is a tendency to use some type of logit (or probit) specification of the model:

$$P(crisis) = \frac{\exp(\alpha_i \mathbf{x})}{\sum_{j=0}^{n} \exp(\alpha_i \mathbf{x})},$$

where X is a vector of independent crisis factors.

In regressions dependent variable is a dummy that takes value 1 for crisis and 0 otherwise. In multinominal models (Hardy and Pasarbasioglu, 1998, 1999) dummy

takes different values for pre-crisis years, severe problems and systemic crisis, and 0 otherwise.

Inconsistency between results of case studies and empirical econometric studies to out opinion arises because the latter treat all crises as essentially the same phenomena with common set of reasons. In contrast, case studies show that banking crises erupt rather as a result of crisis syndromes where different factors work in combination to produce the crisis.

When presumption of essentially the same nature of all banking crises is discarded, obtained results seem natural. If different crisis syndromes may be characterized with opposite dynamics of macroeconomic indicators, influence of these factors when these crises are pooled in one regression will be cancelled out and indicator will seem insignificant. Thus wrong model specification is responsible for misleading results.

In construction of a more appropriate model we make a scenario hypothesis. For the purposes of the present research it is important to note the fact that macroeconomic literature reports important links between monetary stabilization, credit expansion and devaluation. Easterly (1996), Khamis (1996) and Stone (1998) showed that successful stabilizations are followed by rapid increase of money in real terms (or, otherwise stated, credit expansion). In the longer term there is particularly high rate of devaluations among Exchange-rate-based-stabilizations - ERBS (Hamann, 1999). And for devaluations preceding credit growth is also a contributing factor. In complete version it becomes a sort of high inflation - stabilization - devaluation - high inflation sequence (see e.g. Dornbusch, Sturzenegger, and Wolf (1990)).

Most risky for banking system stages are:

(1) inflation stabilization - typically first one or two years since stabilization program started;

(2) end of post-stabilization credit expansion - 3rd through 5th years since start of stabilization program

(3) devaluation - it is likely to follow ERBS. Timing is very uncertain, but typically devaluation is preceded by slow down of credit expansion. It may happen even 15 years after start of stabilization, but most devaluations happen in 10 years period.

We selected 3 key macroeconomic risk indicators - inflation rate change, credit growth and real exchange rate change. During monetary stabilization dynamics of these three indicators tends to be connected and all 3 affect banking system soundness in its own way.

During inflation stabilization inflation rate slowdown leads to fall in interest rates and decrease of interest rates spread. As a result reduction of real net interest income along with other inflationary sources of banks' income may lead to losses and crisis if banks' falling real income does not cover constant operating expenses. In this conditions credit growth increases real income base of banks and thus decreases probability of crisis.

On the next stage increase in loan portfolio fuelled by monetary stabilization and recovery of real sector leads to accumulation of credit risks by banks. If at the same time stabilization is achieved by fixing exchange rate competitiveness of real sector soon deteriorates and loans accumulated with continued growth expectations may sour and lead to a banking crisis. Thus we expect conjunction of credit growth and real exchange rate appreciation to be most dangerous.

Finally we insist that post-devaluation banking crisis is a special case. Massive devaluation almost by definition leads to a banking crisis. It may be triggered by external borrowings of financial sector (that lead to low or even negative net foreign assets of the banking system), by failure of enterprises working on internal market to service their foreign-exchange loans and other factors. Devaluation is typically preceded with credit growth slow down of even credit contraction, thus in contrast with the previous type of banking crisis here decrease of real exchange rate is accompanies with low or modes credit growth.

Data set available allows us to test this model on data for cross-country sample. For cross-country sample we expect significant differences between coefficients before risk variables in the model for different crises types.

4. Theoretical model

Selection of important macroeconomic factors and their influence on banking soundness should start from microeconomic analysis of bank operations. Most studies use more of less complicated bank profitability model (see Shaffer, 1993; Dmitriev et. al., 1996). Its most general form may be written as follows:

$$\Pi = i_C \times C - i_L \times L - Fr \times P$$

$$i_C = \frac{\sum C_{R,j} \times ((1 + r_{RC,j}) \times (1 - d_j) \times J_{p,j} - 1) + \sum C_{\$,k} \times ((1 + r_{\$C,k}) \times (1 - d_k) \times J_{\$,k} - 1)}{\sum C_j + \sum C_k}$$

$$i_L = \frac{\sum L_{R,j} \times ((1 + r_{RL,j}) \times J_{p,j} - 1) + \sum L_{\$,k} \times ((1 + r_{\$L,k}) \times J_{\$,k} - 1)}{\sum L_j + \sum L_k}$$

Π - bank profit

C - loans of banks (in rubles - R, in foreign currency - $)

rRC,j - real interest rate on ruble loans (j-th type)

r$C,k - interest rate on dollar-denominated loans (k-th type)

d - default rate for loans in rubles (j) and foreign currency (k)

L - liabilities of banks (in rubles - R, in foreign currency - $)

$r_{RL,j}$ - real interest rate on ruble liabilities (j-th type)

$r_{\$L,k}$ - interest rate on dollar-denominated liabilities (k-th type)

$J_{p,j}$ - inflation rate for the period

$J_{\$,k}$ - rate of currency depreciation for the period

F_r - net non-interest income (expense) in real terms

P - price level (accumulated inflation)

Model used in this study is basically the same and is recomposed to identify influence of particular factors.

Influence of Inflation rate change

The model could be recomposed to make explicit effect of inflation rate change.

$$\Pi = ((1 + i_{Cr}) \times Jp - 1) \times Cr \times P - ((1 + i_{Lr}) \times Jp - 1) \times Lr \times P - Fr \times P$$

Π - bank profit

C - loans of banks in real terms

L - liabilities of banks in real terms

F_r - net non-interest income (expense) in real terms

r_{Cr} - real interest rate

r_{Lr} - real interest rate liabilities

$J_{p,j}$ - inflation rate for the period

P - price level (accumulated inflation)

This simpler model shows that all the rest equal higher rate of inflation leads to higher bank profits. Inflationary environment typically leads to decrease of real assets and real interest rates, but operating expenses tend to grow in teal terms. As a result of several years of high inflation bank's operating expenses remain the same if not grow,

but banks real assets decrease. When inflation rate falls banks are unable reach pre-inflation equilibrium and are likely to suffer losses. Banking crisis in these conditions is likely to happen due to loss of capital when inflation goes down. The other factor that undermines banks' profitability is decrease of inflation-driven sources of income - income from currency trading and float on payments.

Influence of Real exchange rate change

Influence of real exchange rate change on banking soundness comes from two effects: net foreign currency position income (net foreign currency revaluation) and influence of real exchange rate change on credit quality and resulting loan loss performance.

The general identity above may be rewritten as sum of net foreign exchange income, net interest income less reserves for loan losses and operating expenses:

$$\Pi = NFEI + NII - RLL - F$$

Π - bank profit

NFEI - net foreign exchange rate income

NII - net interest income

RLL - reserves for loan losses

F - net non-interest income (expense)

Two of the parts of the rewritten equation (namely NFEI and RLL) depend on real exchange rate change.

Real exchange rate appreciation negatively affects banks' soundness through credit quality. Appreciation decreases profitability of national producers and undermines quality of banks' loan portfolio. In fact appreciation is often accompanied with high credit growth financed by external borrowings which leads to accumulation of foreign debts of government, banks and corporations. This trend sets the stage for

possible devaluation. These borrowings in many cases lead to negative value of net foreign exchange assets.

The other component influenced by exchange rate change is net foreign currency income. It is functionally dependent on exchange rate change and net foreign currency assets. Thus both variables are explicitly included in our model. More dangerous are cases of devaluation, which are usually preceded by slowdown of credit growth.

$$NFEI = (C_{\$} - L_{\$}) \times J_{\$} = NFA \times J_{\$}$$

NFEI - Net foreign exchange rate income

$C_{\$}$ - loans in foreign currency,

$L_{\$}$ - liabilities in foreign currency,

$J_{\$}$ - rate of real exchange rate change.

As both appreciation and depreciation are potentially dangerous for banking system soundness we have to separate them in the model. We have chosen credit growth factor for real exchange change variable splitting as two syndromes (devaluation and appreciation) are accompanied with opposite dynamics of real credit growth.

Influence of Credit growth

Credit growth in real terms also has two-fold action. From one side, during high inflation as we noted (see influence of inflation rate change) declining real assets are dangerous as they undermine real income base to cover operating expenses. So growth or even just modest decline of real loans helps to prevent banking crisis in conditions of highly inflationary environment.

On the other hand, fast credit growth is one of the most widely cited reasons for bad loans problem in many banking systems (see e.g. Gavin and Hausmann (1996), Kaminsky and Reinhart (1996), Honohan (1997)). The reason for that is quite straightforward: credit booms typically involve loan extension to new borrowers and

even sectors of the economy with no track record that could help to estimate future credit quality.

Here we also face a situation where the same dynamics of real loan portfolio have the opposite effect on bank's soundness depending on macroeconomic conditions. For credit growth variable we also introduce variable splitting. One variable will indicate credit growth in highly inflationary economy, and we expect it to decrease probability of banking crisis. The other will indicate credit growth in low-inflation economy, and we expect it to increase probability of the crisis.

On theoretical grounds we have to include in the model three macro variables: inflation rate change, real exchange rate change and real credit growth, but the latter two variables are expected to have different effect in different circumstances. We introduce in the model variable splitting to take this into account and expect opposite signs before pair variables.

5. Data description and choice of explanatory variables

Sample description

Cross-country analysis is done on the basis of data for high inflation economies. "Inflation stabilization" following approach of Easterly (1996) was defined as a movement from an "inflation crises" to "non crises" period where the former is defined as a period of at least two consecutive years with inflation above 40% percent and the latter as a period of at least two consecutive years with inflation below 40% percent. Easterly used a 40% threshold, as 40% threshold level was found by Bruno and Easterly (1995) to be useful in discriminating between periods of very high inflation and moderate to low inflation. Two year minimum is used to eliminate spikes of inflation due purely to one-time price shocks such as changes in key import prices, devaluations

or price liberalizations. The year of stabilization ("year 0") was defined as a year when 40% threshold was crossed.

As a result using macroeconomic data from World Development Indicators CD-ROM, World Bank, for the period of 1970-1999 we got a sample of 46 countries.

Table 1. Groups of high inflation countries included in the sample

Country group	Country coverage
Transition economies	Albania, Armenia, Azerbaijan, Belarus, Bulgaria, Croatia, Estonia, Georgia, Kazakhstan, Latvia, Lithuania, Macedonia, Poland, Romania, Russia, Ukraine
Latin America	Argentina, Bolivia, Brazil, Chile, Dominican Republic, Ecuador, Jamaica, Mexico, Nicaragua, Peru, Uruguay, Venezuela
Africa	Angola, Congo Democratic Republic, Ghana, Guinea-Bissau, Mozambique, Nigeria, Sierra Leone, Uganda, Zambia
Other	Iceland, Indonesia, Israel, Lao People's Democratic Republic, Mongolia, Turkey, Yemen Arab Republic

Dating of banking crises is quite complicated. To start, researchers have to identify situations that can be termed full-fledged banking crises. Stresses in the banking system are very difficult to quantify. The data necessary for making an assessment are generally not available and, as a result, dating of banking crises must rely on events such as the closure of banks and official support for (and/or government takeover of) financial institutions. Generally, banking sector weaknesses emerge because of deterioration in asset quality. Reliable and timely data on nonperforming assets is not always available and even indirect evaluations of asset quality require information on bankruptcies, exposures of financial intermediaries to different sectors, and movements in real estate and other asset prices—information that is generally not available in many developing and transition economies.

The other intrinsic problem with data on banking crises is linked to arbitrary nature of dating the crises. Country data on banking crises are based on case studies that usually do not use common methodology and report uniform data to make cross-country comparisons possible. As a result for banking crisis detection one needs to rely not on quantitative, but qualitative data collected from numerous sources, mostly case studies of banking crisis. In mid 1990s there were undertaken several quite extensive attempts to collect such data in compact form. These studies now serve as a primary source of data on banking crisis.

Dating of banking crises is based on two such studies: Lindgren, Garcia and Saal (1996) and Caprio and Klingebiel (1999), which is an updated version of original data set for 1996 study. These studies employ different definitions of banking crisis, but both discern two types of banking distress: significant problems and banking crisis.

Demirguc-Kunt A. and Detragiache E. (1997) proposed a set of formal criteria to diagnose a crisis:

1. The ratio of non-performing assets to total assets in the banking system exceeded 10%;
2. The cost of rescue operation was at least 2 percent of GDP
3. Banking sector problems resulted in a large scale nationalization of banks;
4. Extensive bank runs took place or emergency measures such as deposit freezes, prolonged bank holidays, or generalized deposit guarantees were enacted by the government in response to the crisis.

A bit different approach is used by Lindgren, Garcia and Saal (1996). They distinguish two type of banking problems "crisis" and "significant". The former is diagnosed in "cases where were runs or other substantial portfolio shifts, collapses of financial firms, or massive government intervention took place", the latter is defined as

"extensive unsoundness short of a crises". The authors acknowledge some degree of judgment in this classification, but considering fragmented data from case studies they assets this remains the only option available for off-site researcher.

Caprio and Klingebiel (CK) collected data on 165 episodes of bank insolvency since the late 1970s, of which 114 are episodes of systemic banking crisis (much or all of bank capital were exhausted) in 93 countries and 51 episodes of borderline and non-systemic banking crisis in 46 countries. "It relies upon the assessment of a variety of finance professionals. Only published sources or interviews with experts familiar with individual episodes were employed. The dates attached to the crises reviewed those generally accepted by finance experts familiar with the countries. Some judgment has gone into the list [of systemic episodes]."

Lindgren, Garcia, and Saal (LGS) collected data of IMF desk economists, Sheng (1996), Caprio and Klingebiel (1996), Sundararajan and Balino (1991), and various official and news publications. Two general classes of bank distress are identified: "crisis" and "significant" problems. The authors acknowledge some degree of judgment in these classifications, but in general "refer to cases where there were runs or other substantial portfolio shifts, collapses of financial firms, or massive government intervention, as crises. Extensive unsoundness short of a crisis is termed significant."

Both studies generally specify starting and ending dates at annual frequency, although in several cases crises that have emerged recently are treated as ongoing. Thus most of the crises have definite length, for some there is also a figure of cost in percent of GDP. Caprio and Klingebiel (1999) present it in more uniform and complete way.

To our opinion data of Caprio and Klingebiel (1999) is better then that of Lindgren, Garcia and Saal (1996) not only because it is closer to our days but also their definition of crisis dates is more concrete. Lindgren, Garcia and Saal (1996) tend to

overextend crises. For example, in Russia crisis is dated as "1992-present". Obviously this is too rough definition, as most on-site researches report a banking boom in 1992-1994 and banking crisis in 1995 with fast recovery in 1996. Caprio and Klingebiel in contrast report two crisis years: 1995 and 1998. For these reasons data on crisis episodes in this study comes mostly from Caprio and Klingebiel (1999) with reference to Lindgren, Garcia and Saal (1996) in case of doubts.

Table 2. Differences in dating crises between Caprio and Klingebiel (1999) and Lindgren, Garcia and Saal (1996)

	Number of crises
1. No differences in starting date and length	83
2. The same starting date but different length	6
3. Different starting date of the crisis	38
4. Crises that appear only in LGS (1996) sample	27
5. Crises that appear only in CK (1999) sample	32
Total number of crises	186

Banking crisis variable

Data from these two studies allowed to select and date banking crises in our sample. All years classified as "crisis" in Lindgren, Garcia and Saal (1996) and/or Caprio and Klingebiel (1999) except starting year were omitted from regression, starting year was marked as crisis and 1 value and 0 otherwise.

Table 3. Sample of banking crises.

Country	Period of crisis		Type	Length,	Cost,
	start	end	*	years	% of GDP
Albania	1992	present	1		
Angola	1991	present	1		
Argentina	1980	1982	2	3	4.0
Argentina	1989	1990	2	2	
Argentina	1995		2	1	

Country	Period of crisis		Type	Length,	Cost,
	start	end	*	years	% of GDP
Armenia	1994	present	1		
Azerbaijan	1995	present	1		
Belarus	1995	present	1		
Bolivia	1986	1987	1	2	
Bolivia	1994	present	1		4.2
Brazil	1994	present	1		
Bulgaria	1991	present	2		
Chile	1981	1987	2	7	29.0
Congo, DR	1994	present	2		
Croatia	1995		1	1	
Dominican Republic	1992	present	1		
Ecuador	1995	present	1		
Estonia	1992	1995	2	3	1.8
Georgia	1991	present	1		
Ghana	1983	1989	1	7	3.0
Guinea-Bissau	1996		1		
Guinea-Bissau	1988	1990	1		
Iceland	1985	1986	1	2	
Iceland	1993		1	1	
Indonesia	1992	present	1		2.0
Israel	1983	1984	1	2	
Jamaica	1994	present	1		
Kazakhstan	1991	1995	1	4	4.5
Lao PDR	early 1990s		1		
Latvia	1995	present	2		
Lithuania	1995	present	2		
Macedonia	1993	1994	2	2	
Mexico	1982		2	1	
Mexico	1994	present	2		6.5
Mongolia	1991	present	1		
Mozambique	1988	1993	1	6	

Country	Period of crisis		Type	Length,	Cost,
	start	end	*	years	% of GDP
Mozambique	1994	1995	1	2	
Nicaragua	late 1980s	present	1		
Nigeria	1991	1995	1	5	
Peru	1983	1990	1	8	
Poland	1991	present	1		
Romania	1990	present	1		
Russia	1995		1		
Russia	1998	present	1		
Sierra Leone	1990		1	1	
Turkey	1982		2	1	
Turkey	1991		2	1	
Turkey	1994		1	1	1.0
Uganda	1990	present	1		
Ukraine	1994	present	1		
Uruguay	1981	1985	2	5	
Venezuela	1994	present	2		17.0
Yemen Arab Republic	1996		1		
Zambia	1994	present	1		

* - type of crisis: 1 - significant, 2 - crisis

Sources:

1. Demirguc–Kunt A., Detragiache E. The Determinants of Banking Crises in Developing and Developed Countries. //IMF Staff Papers, Vol.45, N1, March 1998b.

2. Hardy D.C., Pazarbasioglu C. Leading Indicators of Banking Crises: Was Asia Different? //IMF working paper, June 1998

3. Frydl Ed.J. The Length and Cost of Banking Crises //IMF Working Paper WP/99/30. - 1999.

4. Lindgren C.-J., Garcia G., Saal M. I. Bank Soundness and Macroeconomic Policy, Washington: IMF, 1996;

Explanatory variables

One of the most difficult tasks was to design variables that will capture in one figure several aspects of macroeconomic changes.

Inflation rate change variable should reflect both reduction of inflation rate in the current year relative to several previous ones. Ratio of inflation rate in year t to inflation rate year t-1 does not differentiate between shift from low to very low inflation and very high and high inflation. Of the several variables tested the best results were obtained from one with this definition: Change of inflation rate in 3 years (infl3) – ratio of inflation rate (π) in the current year to average inflation rate index for the period of 3 previous years:

$$Infl3 = \frac{\pi_t}{\sqrt[3]{(1+\pi_{t-1})\times(1+\pi_{t-2})\times(1+\pi_{t-3})}}$$

Devaluation variable was more straight forward: it was defined as Real Exchange Rate change – ratio of exchange rate index ($1+e_t$) in the current year to inflation rate index ($1+\pi_t$):

$$J_{RER} = \frac{(1+e_t)}{(1+\pi_t)}$$

Credit growth variable was calculated as difference of Credit (Cr) to GDP ratio in the current year and the same ratio 2 years prior. 2 year period has proved to perform best in the model.

$$CrGr = \frac{Cr_t}{GDP_t} - \frac{Cr_{t-2}}{GDP_{t-2}}$$

Based on economic reasoning we expect different sign before credit growth and Real Exchange Rate change index variables in different conditions. To capture this effect we have split these two variables into 2 ones.

Credit growth effect should decrease probability of crisis (or at least not increase it) during high inflation stage. As we selected as a threshold for high inflation 40% p.a. rate we used it also for splitting variables.

(1) Credit growth in high inflation environment:

$$CrGr1 = \begin{cases} CrGr, & CPI > 40\% p.a. \\ 0 & CPO <= 40\% p.a. \end{cases}$$

(2) Credit growth in low inflation environment:

$$CrGr2 = \begin{cases} CrGr, & CPI <= 40\% p.a. \\ 0 & CPO > 40\% p.a. \end{cases}$$

Similarly, we expect different sign before Real Exchange Rate change variable when credit growth flattens and when it accelerates. Real Exchange Rate appreciation tends to decrease credit quality (thus, increasing probability of crisis), when combined with credit growth it is an early warning for future crisis. Real Exchange Rate depreciation which is equally risky is usually preceded by credit growth slowdown and sometimes even decrease in lending. . This two opposite effects tend to offset each other if real exchange rate change is included in regression as one variable. We split Real exchange rate change variable variable into two ones based on the following rule:

(1) Real Exchange rate change accompanied by high Credit growth:

$$REchg1 = \begin{cases} RERchg, & CrGr > A \\ 0 & CrGR <= A \end{cases}$$

(2) Real Exchange rate change accompanied with modest Credit growth or credit contraction:

$$REchg2 = \begin{cases} RERchg, & CrGr < A \\ 0 & CrGR => A \end{cases}$$

A – parameter reflecting threshold value for high credit growth, our tests proved 5% of GDP change in 2 years to be the best parameter's value.

Other variables were included in regression to account for other influencing factors that may on their own affect bankintg system vulnerability to crisis.

Liquid assets of banks to assets ratio – to account for the effect of initial banking system's liquidity.

We tried a proxi of adequacy ratio - capital to assets ratio (from IMF grouping of accounts of credit organizations), but regression showed no connection. The probable explanation is methodological fault of calculation that has little to do with IAS or GAAP. E.g. in Russia after 1998 crisis this indicators only slightly dropped, in fact it dropped much faster in relatively safe 1995-1997.

Net foreign assets variable of banking system and monetary authorities as % of GDP to measure banking system's and/or monetary authorities ability to counter adverse trends in forex market.

Liquid liabilities (M3) as a % of GDP is supposed to measure effect of depth of financial system. In theory effect of this variable is ambiguous as low level of financial intermediation may make banking systems too vulnerable to minor changes in macroeconomic environment. On the other hand it may diminish influence of banking system in the economy to serving overly profitable sectors or external support readily available as it would require modest amount of funds.

Summary of the macroeconomic variables used is in the table 4.

Table 4. Variables used in cross-country estimation

Variable name	Description	Comment
Cri	Crisis dummy (dependent variable)	1 – crisis, 0 – non-crisis
Infl3	Stabilization variable	CPI in year t / average CPI in years t-1 to t-4
CrGr1	Credit growth in high inflation environment	Credit to GDP ratio in year t less Credit to GDP ratio in year t-4, if CPI is over 40% p.a., and 0 othervise
CrGr2	Credit growth in low	Credit to GDP ratio in year t less Credit to GDP

Variable name	Description	Comment
	inflation environment	ratio in year t-4, if CPI is below 40% p.a., and 0 othervise
RERchg1	Real echange rate change accompanied with fast credit growth	Exchange rate index / Inflation rate index, if value of CrGr variable is over 5%, and 0 othervise
RERchg2	Real echange rate change accompanied with modest credit growth	Exchange rate index / Inflation rate index, if value of CrGr variable is below 5%, and 0 othervise
LA_A	Liquid assets of banks to assets ratio	Source: World Development Indicators
NFA_GDP	Net foreign assets variable of banking system and monetary authorities as % of GDP	Source: World Development Indicators
M3_GDP	Liquid liabilities (M3) as a % of GDP	Source: World Development Indicators

6. Model specification

In our model for cross-country estimation probability of banking crisis is explained by a vector of risk factors X.

$$P(Crisis) = f(X)$$

Most suitable for this type economic model is simple logit model where dependent variable denotes crisis. This type of model was used in most studies to discern between crisis and non-crisis period. But here in contrast we split some variables to get separate variables for different crisis types.

Econometric model formulation is

$$P(crisis) = \alpha_i \mathbf{x} + \varepsilon_j$$

P – probability of banking crisis,

X – vector of explanatory variables,

In logistic functional form the model was specified:

$$P(crisis) = \frac{\exp(\alpha_i \mathbf{x})}{\sum_{j=0}^{n} \exp(\alpha_i \mathbf{x})}$$

The model is estimated by maximum likelihood.

7. Estimation results

Estimation results are presented in Appendix 1. Regressions largely support presented hypotheses.

At first stage we tried to mimic results of the previous studies by running conditional fixed-effects logit regression on the sample without variable splitting. In this calculation the only highly significant variable is inflation rate change, while credit growth is only marginally significant. Real Exchange Rate change is as in most other studies insignificant. This result is in line with one of the cited authors. But then we estimated on the same data the model presented in this study and obtained completely different results.

As before inflation rate change remained significant at 95% confidence level. This is a result usually obtained in other studies. After splitting both Credit Growth variables (CrGr1 and CrGr2) increased significance but received opposite signs.

Credit growth in highly inflationary environment (CrGr1) has negative sign. This is in line with our observation that credit growth supports income base in real terms, or in case of highly inflationary environment - credit contraction decreases it thus making crisis more profitable. On the other side credit growth in low inflation environment

(CrGr2) is also a clear risk factor. Relatively low significance may reflect the fact that part of the total influence is attributable to the action of more important factor - real exchange rate appreciation (RERchg1).

One of the searched results is significance of both split Real Exchange Rate change variables - RERchg1 and RERchg2 in contrast with insignificance of the single variable in the previous regression. When we isolated episodes of low credit growth (RERchg2) from episodes of high credit growth (RERchg1) we have in effect isolated devaluation from appreciation. As a result devaluation variable (RERchg2) obtained high significance with expected positive sigh (faster growth of foreign exchange rate then inflation rate in conditions of low credit growth does lead to crisis). A pair variable - Real Exchange Rate Change during high credit growth (RERchg1) also became significant with opposite negative sign. Again it also runs in line with our previous theoretical discussion that credit growth accompanied with real exchange rate growth is a warning factor.

Our variables that control for other factors of banking system risk in both regressions showed expected signs but with different significance. Excess liquidity does decrease probability of crisis. In fact even banking system insolvency is unlikely to erupt in a banking crisis if there are no liquidity problems. Some of post-inflationary banking crises are likely to be missed if banking system inherited from high inflation times fat liquidity cushion.

Sign before depth of financial system variable measured by M3 to GDP ratio (M3_GDP) that on theoretical grounds might have appeared with both signs turned negative. In shows that smaller financial systems are more vulnerable. Possibly it reflects also the effect of maturity of financial system which often implies less variation of the main financial indicators. Although this variable is significant only at 90% level.

The 3rd control variable - Net foreign assets of financial system to GDP ratio (NFA_GDP) although has shown expected sign (negative) is not very significant. Possibly, it is a result of the fact that this factor is important only for one of the 3 selected types of the crisis - namely post-devaluation crisis - and has little to do with the rest two.

In conjunction with this calculation with split variables, results of traditional models may be interpreted very differently. Usually it is said that influence of devaluation is captured by other "structural" variables. In our model coefficients before real exchange rate change variable took opposite signs depending on dynamics of other variables, i.e. the type of the crisis. In simpler model influence of devaluation variable may be just netted-out as it works differently depending on circumstances.

8. Conclusions

The results of the present research confirm the scenario hypothesis of banking crisis development. In contrast with traditional econometric modeling of banking crises in this study we suggested that some factors of banking crisis act not independently but in conjunction with other factors. Moreover in some scenarios influence of the given factor of risk may be opposite when seen in combination with other factors.

Other econometric models that do not distinguish between crisis scenarios miss very important sides of the problem and thus obtain sometimes disappointing results. Macroeconomic factors work in combination to produce banking crisis and not independently as assumed in other models. And some of the risk factors take opposite signs for different types of the crisis. Models that do not recognize different crisis types tend to select as significant risk factors only those those act always in the same manner. Most notorious example of missing evidence is lack of support for devaluation as a risk factor of the crisis. That happens because real exchange rate appreciation is a risk factor

in combination with fast credit growth. On the other hand sharp real exchange rate depreciation that is typically preceded with credit growth lowdown or even contraction triggers banking crisis as shows the model presented in this paper. Thus, opposite dynamics of real exchange rate in the run up to the crisis both act as risk factors but in different crisis syndromes but are "cancelled out" if pooled in one regression.

The other inference from the model is that authorities of high inflation countries must be prepared to fight not one as it is usually suggested but three different crises that may occur all in sequence or some of potentially dangerous developments may not end in full-fledged banking crisis. The possible reason for missing some types of the crisis may be other factors that may soften negative impact. For instance, high liquidity may well help bank to suffer losses without affecting their ability to serve deposits in the short-run.

The full sequence of crises is:

- post-inflation banking crisis that happens just after start of stabilization,
- post-stabilization crisis in the end of the period of fast credit growth in conditions of relative price stability, if accompanied with exchange rate appreciation credit growth is very likely to create conditions of banking crisis development,
- post-devaluation crisis that erupts if stabilization ends with devaluation.

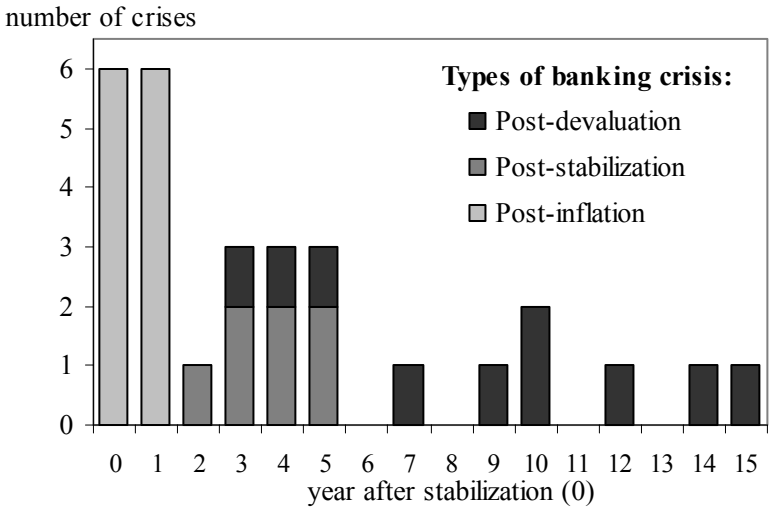

Figure 1. Distribution of banking crises incidence relative to stabilization year in high inflation-economies.

Graphic illustration of distribution of banking crises relative to stabilization date in our sample is presented on figure 1.

All post-stabilization crises are concentrated in the 2nd to 5th years of stabilization. Devaluation crises are the last in series of possible crises. They are spread over 13-year period in our sample, which is consistent with macroeconomic literature.

Russian experience well fits this scheme. Russia had all three crises. Russian stabilization started early in 1995 with effective fixing of exchange rate with following 10% nominal ruble appreciation. Post-inflation banking crisis in Russia was manifested in August 1995 by interbank loans crisis. This crisis started process of massive license withdrawal in 1995-1996 (in more detail see Dmitriev et. al. (1996)). Post-stabilization crisis in the beginning of 1998 led to some famous banks failures even before August 1998 devaluation, but devaluation has precipitated even more spectacular crisis that is much more known.

Bank supervision and adequate bank management are essential to minimize potential losses. Regulators and bankers must know what risks stabilization brings and what they must prepare themselves to.

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Appendix 1. Estimation results for cross-country sample

The model: conditional fixed-effects logit regression

		Number of obs	= 814
		Number of groups	= 46
		Obs per group: min	= 9
		avg	= 17.7
		max	= 29
		LR chi2(3)	= 4.85
Log likelihood = -114.43704		Prob. > chi2	= 0.0042

Cri	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Infl3	-0.0249488	0.012481	-1.999	0.046	-0.04941	-0.00049
CrGr1	-2.695608	1.310504	-2.057	0.040	-5.26415	-0.12707
CrGr2	0.0405295	0.022762	1.781	0.075	-0.00408	0.085141
RERchg1	-3.299308	1.005192	-3.282	0.001	-5.26945	-1.32917
RERchg2	3.263575	1.19656	2.727	0.006	0.918361	5.608789
LA_A	-.0375454	.0159546	-2.353	0.019	-.0688158	-.0062751
NFA_GDP	-0.34024	0.236622	-1.438	0.150	-0.80401	0.123527
M3_GDP	-0.0399604	0.023413	-1.707	0.088	-0.08585	0.005928

Alternative model (no variable splitting): conditional fixed-effects logit regression

		Number of obs	= 814
		Number of groups	= 46
		Obs per group: min	= 9
		avg	= 17.7
		max	= 29
		LR chi2(3)	= 7.54
Log likelihood = -103.74085		Prob. > chi2	= 0.0286

Cri	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Infl3	-0.02687	0.012831	-2.094	0.036	-0.05202	-0.00172
CrGr	0.0215886	0.014579	1.481	0.139	-0.00699	0.050163
RERchg	-0.0059203	0.027164	-0.218	0.827	-0.05916	0.047321
LA_A	-0.075672	0.033434	-2.263	0.024	-0.141201	-0.010143
NFA_GDP	-0.02668	0.01865	-1.431	0.153	-0.00987	0.063233
M3_GDP	-1.174255	0.649407	-1.808	0.071	-2.44707	0.098559

Appendix 2. Banking crises in 1970-1999

Country	Period of crisis		Type *	Length, years	Cost, % of GDP
	start	end			
Albania	1992	present	1		
Algeria	1990	1992	1	3	
Angola	1991	present	1		
Argentina	1980	1982	2	3	4.0
Argentina	1989	1990	2	2	
Argentina	1995		2	1	
Armenia	1994	present	1		
Australia	1989	1992	1	4	
Azerbaijan	1995	present	1		
Bangladesh	1980	present	1		4.5
Belarus	1995	present	1		
Benin	1988		2	1	
Buhtan	1990	present	1		
Bolivia	1986	1987	1	2	
Bolivia	1994	present	1		4.2
Bosnia-Herzegovina	1992	present	1		
Botswana	1994	1995	1	2	
Brazil	1994	present	1		
Brunei Darussalam	mid 1980s		1		
Bulgaria	1991	present	2		
Burkina Faso	1988	1994	1	7	
Burundi	1994	present	1		
Cambodia			1	1	
Cameroon	1989	1993	2	5	
Cameroon	1995	present	2		
Canada	1983	1985	1	3	
Cape Verde	1993	present	1		
C.A.R.	1986	1992	2	7	
C.A.R.	1995	present	1		
Chad	1979	1983	2	5	
Chad	1992		1	1	
Chile	1981	1987	2	7	29.0
China	1980s	present	1		
Colombia	1982	1985	1	4	
Congo, Democratic Republic	1994	present	2		
Costa Rica	1994	present	2		
Cote d'Ivoire	1988	1990	1	3	
Croatia	1995		1	1	
Czech Republic	1991	present	1		12.0
Denmark	1987	1992	1	6	
Djibuti	1991	1993	1	3	
Dominican Republic	1992	present	1		
Ecuador	1995	present	1		
Egypt	1991	1995	1	5	
El Salvador	1989		1	1	

Country	Period of crisis		Type	Length,	Cost,
	start	end	*	years	% of GDP
Equatorial Guinea	1983	1985	2	3	
Equatorial Guinea	1995		1	1	
Eritrea	1994		1	1	
Estonia	1992	1995	2	3	1.8
Ethiopia	1994	1995	1	2	
Fiji	1995	present	1		
Finland	1991	1994	2	4	8.4
France	1991	1995	1	5	0.6
Gabon	1995	present	1		
Gambia, The	1985	1992	1	8	
Georgia	1991	present	1		
Germany	1990	1993	1	4	
Ghana	1983	1989	1	7	3.0
Greece	1991	1995	1	5	
Guinea	1980	1985	2	6	
Guinea-Bissau	1996		1		
Guinea-Bissau	1988	present	1		
Gyana	1993	1995	1	3	
Haiti	1991	present	1		
Hungary	1987	present	1		9.0
Iceland	1985	1986	1	2	
Iceland	1993		1	1	
India	1991	present	1		
Indonesia	1992	present	1		2.0
Ireland	1985		1	1	
Israel	1983	1984	1	2	
Italy	1990	1995	1	6	
Jamaica	1994	present	1		
Japan	1992	present	1		
Jordan	1989	1990	2	2	
Kazakhstan	1991	1995	1	4	4.5
Kenya	1993		1	1	
Korea	mid 1980s		1		
Kuwait	mid 1980s		2		
Kuwait	1990	1991	1	2	
Kyrgyz Republic	1996		1		
Lao People's Democratic Republic	early 1990s		1		
Latvia	1995	present	2		
Lebanon	1988	1990	2	3	
Lesoto	1988	present	1		
Liberia	1991	1995	2	5	
Lithuania	1995	present	2		
Macedonia	1993	1994	2	2	
Madagascar	1988		1	1	
Madagascar	1991	1995	1	5	
Malaysia	1985	1988	2	4	4.1
Mali	1987	1989	1	3	
Mali	1995		1	1	

Country	Period of crisis		Type	Length,	Cost,
	start	end	*	years	% of GDP
Mauritania	1991	1993	1	3	
Mauritius	1996				
Mexico	1982		2	1	
Mexico	1994	present	2		6.5
Moldova	1994	present	1		
Mongolia	1991	present	1		
Mozambique	1988	1993	1	6	
Mozambique	1994	1995	1	2	
Myanmar	1996		1		
Nepal	late 1980s		1		
New Zealand	1989	1990	1	2	
Nicaragua	late 1980s	present	1		
Niger	1983	present	2		
Nigeria	1991	1995	1	5	
Norway	1987	1993	2	7	3.3
Pakistan	1980	present	1		
Panama	1988	1989	2	2	
Papua New Guanea	1989	present	1		
Paraguay	1995	present	1		
Peru	1983	1990	1	8	
Philippines	1981	1987	2	7	13.2
Poland	1991	present	1		
Romania	1990	present	1		
Russia	1992	present	1		
Rwanda	1991	present	1		
Sao Tome and Principe	1980	present	2		
Senegal	1983	1988	2	6	
Sierra Leone	1990		1	1	
Singapore	1982		1	1	
Slovak Republic	1991	1995	1	5	
Slovenia	1992	1994	1	3	
Somalia	1990		2		
South Africa	1985		2	1	
South Africa	1989	present	1		
Spain	1977	1985	2	9	5.6
Sri Lanka	early 1990s		1		
St. Vincent and the Grenadines	1994	present	1		
Swaziland	1995		1	1	
Sweden	1990	1993	2	4	4.0
Tajikistan	1996		1		
Tanzania	1988	present	2		6.5
Thailand	1983	1987	2	5	
Togo	1989	1991	1	3	
Trinidad and Tobago	1982	1993	1	12	
Tunisia	1991	1995	1	5	
Turkey	1982		2	1	
Turkey	1991		2	1	
Turkey	1994		1	1	1.0

Country	Period of crisis		Type *	Length, years	Cost, % of GDP
	start	end			
Uganda	1990	present	1		
Ukraine	1994	present	1		
US	1980	1992	1	13	2.4
Uruguay	1981	1985	2	5	
Uzbekistan	1993	present	1		
Venezuela	1994	present	2		17.0
Vietnam	1996		1		
Yemen Arab Republic	1996		1		
Zaire	1991	present	1		
Zambia	1994	present	1		
Zimbabwe	1995	present	1		
Number of observations			152	81	22

* - type of crisis: 1 - significant, 2 - crisis

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